Physics 3204 Grading Standards
June 2006

Pre-Marking Appraisal

The examination was considered fair and had sufficient coverage of each unit of study and each level of cognitive learning. The following concern was discussed by the marking board:

Item # 49 – There was a typing error in this item. The unit for mass of $^{23}_{10}Ne$ was absent. This did not cause a problem in completing the item, and therefore it was included in the examination mark.

Post Marking Report

a) Marking Standard and Consistency

Marker reliability was checked by obtaining a random sample of 50 papers. On the first marking day, these 50 papers were marked and the value for each question was recorded on a separate sheet of paper. The 50 papers were put back into the original stack of papers to be corrected over the next week. Throughout the marking period, these reliability papers were corrected by the markers, the two values were compared and if there were discrepancies in the marks, the chief marker would discuss and review the scoring with the individual marker.

b) Summary

Overall performance in the Physics 3204 examination improved from June 2005 to June 2006. As in past years, however, performance was lower for items that assessed outcomes from core Labs and STSE units. Core Labs and STSE units enrich and enhance material in each unit of the course. It is essential that teachers complete all core labs and STSE units to ensure that students are prepared for the examination. On provincial examinations, core Lab and STSE outcomes are often assessed at higher levels of learning. Teachers, therefore, should assess these areas of the course in a similar manner throughout the school year.

Teachers should also encourage students to read questions carefully and critically. Very often on the provincial examination, errors occur because students fail to read the whole question. If they read the complete question or read it several times, they are less likely to misinterpret the item and are more likely to perform better.

c) Commentary on Responses

Part II – Constructed Response - Total Value: 50%

2% 51.(a) A parcel is dropped from a plane flying overhead with a constant horizontal speed of 75 m/s. If the range is 1.2 x 10^3 m, from what height was the parcel dropped? Assume air resistance is negligible. Show workings.

Answer:

v_{1x} =75 m/s

d_x =1.2 x 10^3 m

First find time using $t = \frac{d_x}{v_x} = \frac{1.2x10^3 m}{75 m/s} = 16s$ **1 mark**

Then find the height of the drop,

$d_y = v_{1y}t + \frac{1}{2}a_y t^2$ **0.5 marks**

$d_y = 0 + \frac{(-9.8 m/s^2)(16s)^2}{2}$

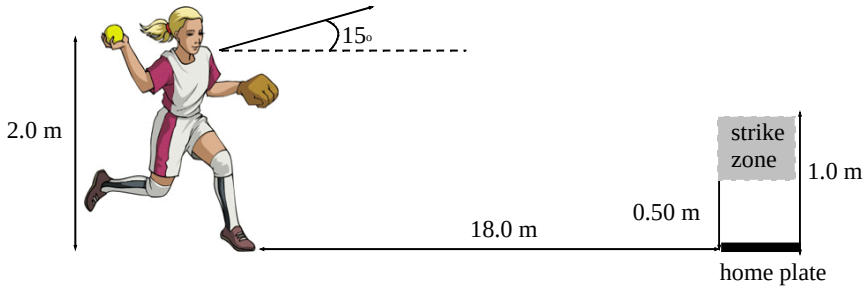
$d_y = 1254.4m$

$d_y = 1.3x10^3 m$ **0.5 marks**

Common Error

Students used $d_x = v_{1y}t + \frac{1}{2}a_y t^2$ to solve for time instead of using $d_x = v_x t$.

4% 51.(b) A strike in baseball occurs between 0.50 m and 1.0 m directly above home plate. A pitcher, 18.0 m from home plate, throws a ball with an initial velocity of 17.0 m/s at 15° above the horizontal. If the ball is released 2.0 m above the ground, will the pitch be a strike? Show workings.



Answer:

Find velocity components:

$v_{1x} = 17.0 m/s \cos 15^\circ = 16.4 m/s$ **0.5 marks**

$v_{1y} = 17.0 m/s \sin 15^\circ = 4.4 m/s$ **0.5 marks**

Then find time:

$t = \frac{d_x}{v_x} = \frac{18.0 m}{16.4 m/s} = 1.10 s$ **1 mark**

Then find vertical drop of the ball:

$d_y = v_{1y} t + \frac{1}{2} a_y t^2$ **0.5 marks**

$d_y = (4.4 m/s)(1.10 s) + \frac{(-9.80 m/s^2)(1.10 s)^2}{2}$

$d_y = -1.089 m$ **0.5 marks**

Therefore the distance above ground at home plate is 2.0 m – 1.089 m = 0.9 m **0.5 marks**

So the pitch is a strike. **0.5 marks**

Commentary on Response

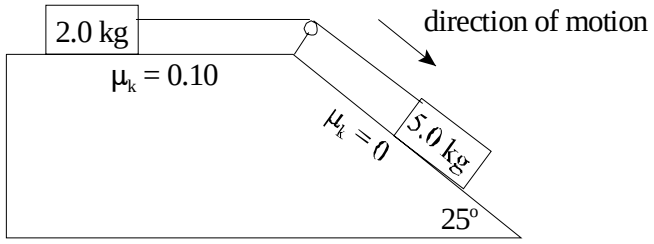
Many students attempted to find the time to maximum height and then the time to the plate. Others attempted to find the time to fall 2.0 m using the quadratic equation. The quadratic equation was not necessary for this item.

Common Errors

Students:

- made errors in setting up the equation (finding the time to drop full 2.0 m).
- confused vertical and horizontal information.
- did not subtract at the end of the problem to get the height above the ground.

4% 51. (c) The diagram below shows two blocks connected by a massless string over a frictionless pulley. What is the acceleration of the system of blocks? Show workings.



Answer:

$$\vec{a} = \frac{\vec{F}_{net}}{m} = \frac{F_{gx} - F_{fr}}{m} = \frac{(5.0kg)(9.80m/s^2)(\sin 25^\circ) - (0.10)(2.0kg)(9.80m/s^2)}{7.0kg} = 2.7m/s^2$$

finding friction force	**0.5 marks**
finding parallel component of gravity	**0.5 marks**
finding F_{net} by subtracting	**0.5 marks**
using a total mass of 7.0 kg	**0.5 marks**
rearranging for acceleration	**0.5 marks**
final answer	**0.5 marks**
science communication skills	**1 mark**

OR Find friction: $F_{friction} = \mu mg = (0.10)(2.0kg)\left(9.80\frac{m}{s^2}\right) = 1.96N$ **0.5 marks**

Find $F_{gparallel}$: $F_{gparallel} = mg\sin\theta = (5.0kg)\left(9.80\frac{m}{s^2}\right)(\sin 25^\circ) = 20.7N$ **0.5 marks**

Find net force on 2.0 kg block:	$2.0a = T - 1.96$	**0.5 marks**
Find net force on 5.0 kg block:	$5.0a = 20.7 - T$	**0.5 marks**
Combine:	$7.0a = 18.7$	**0.5 marks**
Solve for a:	$a = \frac{18.7N}{7.0kg} = 2.7\frac{m}{s^2}$	**0.5 marks**
science communication skills		**1 mark**

Common Errors

Students:

- used the incorrect trigonometric function for the parallel component of gravity.
- added extra forces, such as friction on the incline.

4% 51.(d) A pail of water on the end of a string revolves at a uniform rate in a vertical circle of radius 85.0 cm. Its speed is 4.15 m/s and the mass of the pail and water together is 1.00 kg.

(i) Calculate the magnitude of the tension in the string when the pail is at the top of its path.

Answer:

$T + F_g = F_c$

$T = F_c - F_g$ **0.5 marks**

$T = \frac{mv^2}{r} - mg = \frac{(1.00kg)(4.15m/s)^2}{0.850m} - (1.00kg)(9.80m/s^2)$

$T = 10.5N$ **0.5 marks**

calculating F_c **0.5 marks**

calculating F_g **0.5 marks**

Common Errors

Students:

- did not account for the gravitational force.
- added instead of subtracted.

(ii) At what minimum speed must the pail be travelling when upside down at the top of the circle so that the water does not fall out?

Answer:

At minimum speed, tension = 0 N, therefore,

$F_g = F_c$ **0.5 marks**

$mg = \frac{mv^2}{r}$ **0.5 marks**

$v = \sqrt{gr} = \sqrt{(9.80m/s^2)(0.850m)}$ **0.5 marks**

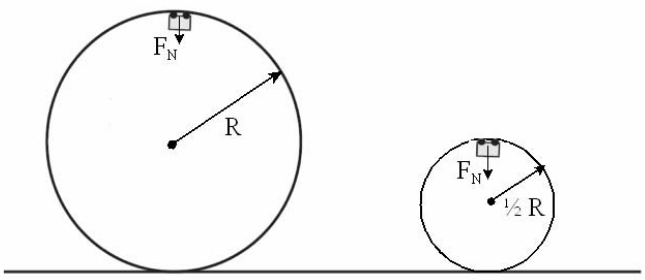
$v = 2.89m/s$ **0.5 marks**

Common Errors

Students:

- did not set tension equal to zero.
- made calculation errors in finding the square root.

2% 51.(e) During a roller coaster ride the riders move through two loops, the second being one half the radius of the first. The riders travel at the same speed at the top of each of these two loops.



Using principles of physics, explain why riders would experience a greater normal force at the top of the smaller loop than at the top of the larger loop.

Answer:

At the top of the loops in each case, $F_N = F_c - F_g$

$$F_N = \frac{mv^2}{r} - mg$$ **0.5 marks**

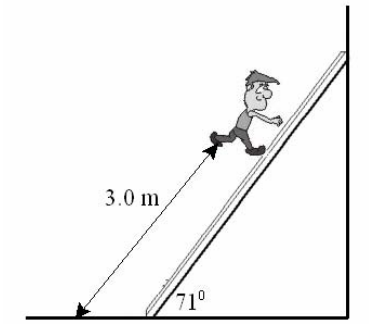
If we decrease the radius then the centripetal force will increase. **1 mark**
Therefore, the normal force will also increase since F_g is constant.
So there is a greater normal force for the smaller loop. **0.5 marks**

Common Errors

Students:

- equated the normal force and the centripetal force and did not include gravity as contributing to the centripetal force.
- incorrectly stated that since the radius on the smaller loop was closer to the ground, a larger gravitational force was experienced. Students then equated this gravitational force with the normal force.
- stated that the smaller radius loop has less distance to travel at the same speed resulting in a larger normal force.

4% 51.(f) The diagram below shows a uniform 7.0 kg ladder resting against a frictionless wall. The person on the ladder has a mass of 65 kg. If the ladder is 5.0 m long, what force does the wall exert on the ladder?



Answer:

$\tau_{wall} = \tau_{person} + \tau_{ladder}$ **0.5 marks**

$F_{wall} \sin 71^{\circ}(5.0m) = (65kg)(9.80m/s^2)(\cos 71^{\circ})(3.0m) + (7.0kg)(9.80m/s^2)(\cos 71^{\circ})(2.5m)$

3 marks

$(4.73m)F_{wall} = 622.16N \cdot m + 55.83N \cdot m$

$F_{wall} = 143.3N = 1.4\ x\ 10^2\ N$ **0.5 marks**

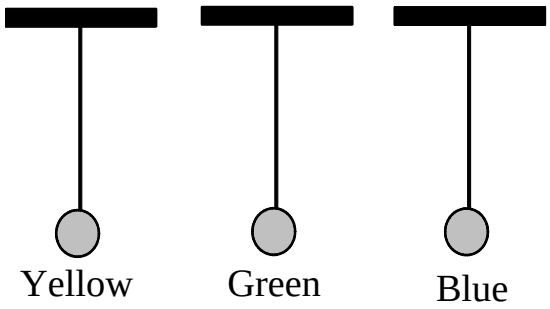
Common Errors

Students:

- used the incorrect trigonometric function or angle in calculations.
- miscalculated the perpendicular component of force.

2% 52.(a) Three different pith balls are suspended by separate strings. Use the information below to determine the charges on the blue and green balls. Explain.

- The yellow ball was charged by induction using a negatively charged rod.
- The blue ball repels the green ball.
- The blue ball is attracted to the yellow ball.



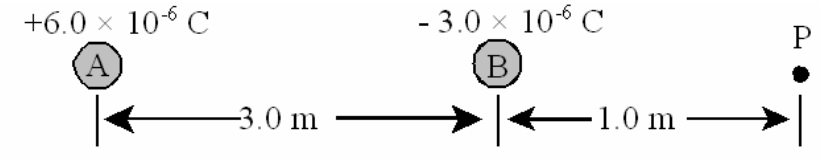
Answer:

Yellow ball is positive because it gets opposite charge through induction with negative rod. **1 mark**
Blue ball is negative in order to attract yellow and repel green. **0.5 marks**
Green ball is negative in order to repel blue. **0.5 marks**

Commentary on Response
One mark was awarded for stating that the blue and green balls were positively charged if the student incorrectly stated that the charge on the yellow ball was negative. No marks were awarded for stating that the blue and green balls were negatively charged if the student incorrectly stated that the charge on the yellow ball was also negative.

Common Errors
Students:
- misunderstood the process of induction.
- stated that protons (or positive electrons or positrons) move.

3% 52.(b) What is the magnitude and direction of the electric field below at point P? Show workings.



Answer:

$$\varepsilon_A = \frac{kQ_A}{r^2} = \frac{\left(9.0x10^9 \frac{N \cdot m^2}{C^2}\right)\left(6.0x10^{-6} C\right)}{\left(4.0m\right)^2} = 3375\frac{N}{C}$$ **1 mark**

$$\varepsilon_B = \frac{kQ_B}{r^2} = \frac{\left(9.0x10^9 \frac{N \cdot m^2}{C^2}\right)\left(-3.0x10^{-6} C\right)}{\left(1.0m\right)^2} = -27000\frac{N}{C}$$ **1 mark**

$$\varepsilon_{net} = 3375\frac{N}{C} - 27000\frac{N}{C} = -23625\frac{N}{C}$$

$$\varepsilon_{net} = 2.4x10^4 \frac{N}{C}(left)$$ **1 mark**

Common Errors

Students:

- used Coulomb's law instead of electric field strength.
- used the incorrect distance.
- did not square the distance.
- added instead of subtracted to get the net field strength.

4% 52.(c) A student measured the potential difference across, and the current through, two circuit elements, X and Y, and obtained the following data.

Element X

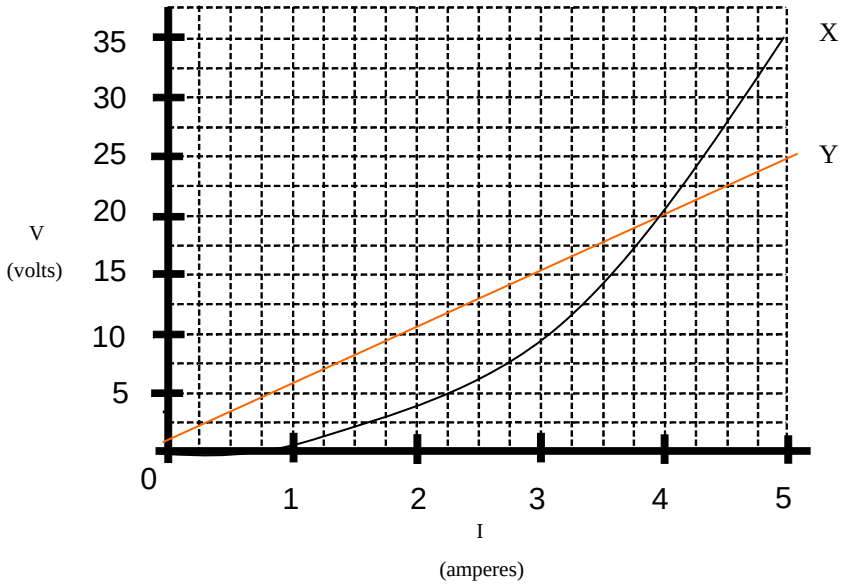
Potential difference (V)	Current (A)
1	1
10	3
35	5

Element Y

Potential difference (V)	Current (A)
5	1
15	3
25	5

(i) Draw a clearly labelled voltage vs. current graph for each element.

Answer:



2 marks - 1 mark for each graph (0.5 marks for each line and 0.5 marks for each label)

Common Error
Students did not label the graphs.

(ii) Which element obeys Ohm's law? Explain.

Answer:
Element Y obeys Ohm's law since it is a linear relationship.

1 mark - 0.5 marks for identifying element Y and 0.5 marks for stating a linear relationship

Common Error
Students stated that the voltage increased without explaining how it increased.

(iii) Calculate the resistance of the element in (ii).

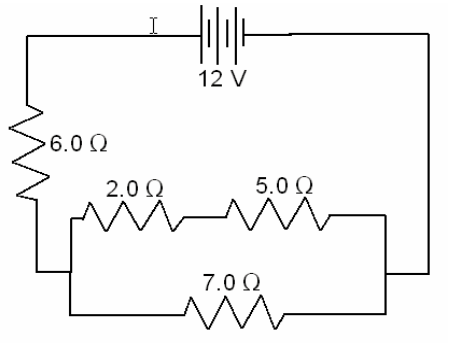
Answer:

Resistance = slope = $\frac{25V}{5A} = 5\Omega$ **1 mark**

Common Errors
Students:

- used $R = \frac{I}{V}$ or $slope = \frac{run}{rise}$.
- calculated three individual resistances and added them together to get one final answer.
- used total voltage by adding all three points together.

4% 52.(d) For the circuit shown in the diagram below, calculate:



(i) the voltage across the 6.0 Ω resistor.

Answer:

$R_{series} = 2.0\Omega + 5.0\Omega = 7.0\Omega$ **0.5 marks**

$R_T = 9.5\Omega$

$I_T = \frac{V_T}{R_T} = \frac{12V}{9.5\Omega} = 1.26A$ **1 mark**

$I_6 = I_T = 1.26A$

$V_6 = I_6 R_6 = (1.26A)(6.0\Omega) = 7.6V$ **0.5 marks**

Common Errors

Students:

- added the 2.0 Ω and 5.0 Ω resistors in parallel instead of series.
- stated that all voltages were 12 V.

(ii) the current through the 5.0 Ω resistor.

Answer:

The current splits evenly through two 7.0 Ω resistors in parallel, so each branch gets half of the 1.26 A. Thus the 5.0 Ω resistor will get 0.63 A. **1 mark**

OR

$V_{parallel} = I_{parallel} R_{parallel} = (1.26A)(3.5\Omega) = 4.4V$

$I = \frac{4.4V}{7.0\Omega} = 0.63A$ **0.5 marks for each step**

Common Errors
Students:
- did not recognize that the current splits evenly.
- calculated the voltage left for the parallel loop and assumed it was the same for all resistors in the loop.
- assumed that the voltage across the 2.0 Ω resistor was the same as the total voltage.

(iii) the power dissipated in the 2.0 Ω resistor.

Answer:
$P = I^2 R$
$P = (0.63A)^2 (2.0\Omega)$
$P = 0.79W$ **1 mark**

Common Errors
Students:
- believed that the voltage was the same across the 7.0 Ω and 5.0 Ω resistors and across the 2.0 Ω and 5.0 Ω resistors.
- assumed that current was the same as the total current.

4% 52.(e) The diagram below shows a proton and an electron entering identical uniform magnetic fields of intensity 0.025 T with the same initial speed of 1.4 x 10^5 m/s.

(i) What is the magnitude of the magnetic force on the electron?

Answer:
$\theta = 90^\circ - 25^\circ = 65^\circ$ **1 mark**

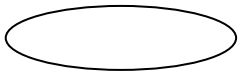
$F = qvB\sin\theta$
$F = (1.6x10^{-19} C)(1.4x10^5 m/s)(0.025T)\sin 65^\circ$
$F = 5.1x10^{-16} N$ **1 mark**

Common Error
Students did not identify the correct angle.

(ii) Sketch the shape of the path taken by the proton and electron after they enter the magnetic fields.

Answer:

Proton:



circular shape

1 mark

Electron:

spiral shape

1 mark

OR:

into the page

1 mark

out of the page at an angle

1 mark

Commentary on Response
Many students misinterpreted the question. They gave direction when all that was required was shape. It was difficult to indicate direction given the three dimensional nature of the question. This is why the descriptions "into the page" and "out of the page at an angle" were also accepted.

Common Error
Students showed the path as being deflected down or up.

3% 52.(f) A proton moves with a speed of 3.6×10^5 m/s at right angles to a uniform 0.75 T magnetic field. What is the radius of curvature for the motion of the proton?

Answer:

$F_{centripetal} = F_{magnetic}$

$\frac{mv^2}{r} = qvB\sin\theta$ where $\sin 90^\circ = 1$ **1 mark**

$r = \frac{mv}{qB} = \frac{(1.673x10^{-27}\,kg)(3.6x10^5\,m/s)}{(1.6x10^{-19}\,C)(0.75T)} = 5.0x10^{-3}\,m$ **1 mark**

1 mark – science communication skills

Common Errors
Students:

- used incorrect formulae (eg. Biot's Law, or banked curve formula).
- assumed current was 1.0 A.
- used the mass of an electron or canceled the mass with the charge.
- did not use the correct value for the charge of a proton.

2% 53.(a) A metal surface has a work function of 4.20 eV. What is the kinetic energy, in joules, of the emitted electrons if the wavelength of light is 250 nm?

Answer:

$hf = E_k + W_o$ **0.5 marks**

$E_k = \frac{hc}{\lambda} - W_o$ **0.5 marks**

$E_k = \frac{\left(6.626x10^{-34}\,J \cdot s\right)\left(3.00x10^{8}\,m/s\right)}{2.50x10^{-7}\,m} - \left(4.20eV\right)\left(1.6x10^{-19}\,J/eV\right)$

$E_k = 1.2x10^{-19}\,J$ **0.5 marks**

0.5 marks – for converting work function to Joules

Commentary on Response
Some students first converted photon energy into eV and then converted the final answer to joules.

Common Errors
Students:

- did not convert units.
- used hf (with incorrect frequency) instead of $\frac{hc}{\lambda}$ for photon energy.
- used $f = \frac{1}{\lambda}$ to find frequency.

3% 53.(b) A photon of light is emitted from a hydrogen lamp when an electron falls from the third energy level to the second energy level. Calculate the energy and the wavelength for this photon.

Answer:

$E_3 = \frac{-13.6eV}{3^2} = -1.51eV$ **0.5 marks**

$E_2 = \frac{-13.6eV}{2^2} = -3.4eV$ **0.5 marks**

$E_{upper} - E_{lower} = -1.51eV - -3.4eV = 1.89eV$ **0.5 marks**

$1.89eV = \frac{hc}{\lambda}$

$\lambda = \frac{hc}{1.89eV} = \frac{(6.626x10^{-34}\ J \cdot s)(3.00x10^{8}\ m/s)}{3.024x10^{-19}\ J} = 6.6x10^{-7}\ m$ **0.5 marks**

0.5 marks – converting energy to joules
0.5 marks – solving for λ

Common Errors
Students:

- did not convert eV into joules.
- added energies instead of subtracted.
- used hf (with incorrect frequency) instead of $\frac{hc}{\lambda}$ for photon energy.
- used $r_n = (5.29x10^{-11}m)n^2$ for energy.

3% 53.(c) Iodine - 131 has a half-life of 8.04 days. If a sample originally has an activity of 2.00×10^6 Bq, how long will it take for it to have an activity of 1.85×10^6 Bq?

Answer:

$$A = A_o\left(\frac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$$

$$1.85x10^6\,Bq = 2.00x10^6\,Bq\left(\frac{1}{2}\right)^{\frac{t}{8.04}}$$ **1 mark**

$$\frac{1.85x10^6\,Bq}{2.00x10^6\,Bq} = \left(\frac{1}{2}\right)^{\frac{t}{8.04}}$$

$$0.925 = \left(\frac{1}{2}\right)^{\frac{t}{8.04}}$$

$$\log 0.925 = \frac{t}{8.04}\log 0.5$$ **0.5 marks**

$$\frac{t}{8.04} = 0.1125$$

$$t = 0.904 days$$ **0.5 marks**

(1 mark – science communication skills)

Common Errors

Students:

- multiplied the half life by 0.5.
- used 8.04 days for time instead of the half life.
- used logarithms incorrectly.

2% 53.(d) When a light bulb in a movie projector is replaced with a bulb that has the same intensity but different frequency, the sound does not work. With reference to the photoelectric effect, explain why this occurs.

Answer:

In order for the photoelectric effect to occur, the energy of the incident photons must be greater than the work function of the metal. **0.5 marks**

Changing the frequency will change the energy of the incident photons so that in this case, no electrons are ejected from the metal. **1 mark**

No electrons = no current = no sound. **0.5 marks**

Commentary on Response

Many students did not attempt this item.

Common Errors

Students:

- did not state the role of electrons, energy, or work function.
- stated that photons are emitted instead of electrons.

TABLE 1
PHYSICS 3204 ITEM ANALYSIS
SELECTED RESPONSE (PART I)

Item	Answer	Responses			
		A	B	C	D
		%	%	%	%
1	B	3.7	81.4	3.2	11.6
2	D	2.1	0.5	0.8	96.6
3	C	5.6	11.5	72.8	9.7
4	C	1.5	2.3	59.8	36.4
5	C	20.7	0.2	77.0	2.0
6	C	11.0	18.1	61.4	9.0
7	D	3.9	20.7	10.9	64.2
8	D	4.3	10.9	15.7	68.9
9	C	2.2	7.0	74.0	16.7
10	B	7.0	60.7	23.3	9.1
11	A	82.6	6.5	6.8	3.9
12	D	5.5	5.1	6.2	82.4
13	C	4.7	6.8	80.6	7.8
14	A	26.1	18.6	41.8	13.5
15	A	30.4	16.0	46.5	6.9
16	A	71.6	16.1	1.8	10.5
17	C	3.4	1.8	86.9	7.9
18	D	11.5	20.4	13.6	53.3
19	A	83.9	10.8	1.6	3.6
20	A	86.9	5.9	1.9	5.4
21	C	6.0	9.9	73.0	11.1
22	B	4.6	74.7	18.8	1.4
23	D	2.3	3.2	11.6	82.9
24	C	5.9	6.8	66.0	21.3
25	D	3.8	5.5	31.9	58.6

Item	Answer	Responses			
		A	B	C	D
		%	%	%	%
26	C	9.6	1.9	82.1	6.4
27	B	2.6	83.1	10.5	3.8
28	B	40.8	26.8	10.1	22.2
29	D	7.9	12.9	10.5	68.5
30	B	22.6	59.7	13.0	4.2
31	A	50.7	19.3	14.4	15.7
32	B	2.6	57.7	38.4	1.3
33	C	6.1	18.2	61.1	14.3
34	A	88.6	9.2	1.1	1.1
35	C	9.2	26.6	56.5	7.7
36	B	13.1	50.6	23.1	13.3
37	A	95.5	1.6	0.8	2.0
38	B	6.3	75.3	11.4	6.0
39	A	81.2	7.2	6.5	5.1
40	A	70.1	10.1	11.6	8.0
41	A	45.4	31.7	13.4	9.2
42	C	4.8	11.4	70.6	12.8
43	C	4.1	6.6	84.3	4.7
44	A	53.2	20.5	14.8	10.3
45	D	5.8	9.9	12.3	71.9
46	A	83.9	8.4	6.2	1.2
47	A	80.8	8.0	7.0	4.1
48	B	9.9	81.4	7.6	1.0
49	A	51.7	19.1	21.7	7.1
50	D	4.5	3.0	2.6	89.8

NOTE: Percentages may not add to 100% due to multiple answers or missing values.

TABLE 2
PHYSICS 3204 ITEM ANALYSIS

CONSTRUCTEDRESPONSE (PART II)

Item	Students Completing Item	Value	Average
51.(a)	966	2	1.6
51.(b)	966	4	2.7
51.(c)	966	4	3.4
51.(d)	966	4	2.8
51.(e)	966	2	0.7
51.(f)	966	4	1.9
52.(a)	966	2	1.4
52.(b)	966	3	1.7
52.(c)	966	4	3.5
52.(d)	966	4	1.8
52.(e)	966	4	1.5
52.(f)	966	3	1.7
53.(a)	966	2	1.3
53.(b)	966	3	1.9
53.(c)	966	3	2.4
53.(d)	966	2	0.5